VESSELS AND VARMINTS

A Workshop on the Next Steps for Ballast Water Management in the San Francisco Estuary

Elihu Harris State Building Auditorium Oakland, California

May 11, 2000

Workshop Sponsored By:

California Regional Water Quality Control Board (San Francisco Bay Region)

Port of Oakland

Center for Marine Conservation

Pacific Merchant Shipping Association

WORKSHOP PRESENTATION SUMMARY DOCUMENT

FORWARD

This document is a compilation of presentation outlines from the "Vessels and Varmints "Workshop, held in Oakland, California on May 11, 2000. The workshop was organized and sponsored by representatives from the California Regional Water Quality Control Board (San Francisco Bay Region), the Port of Oakland, the Center for Marine Conservation, and the Pacific Merchant Shipping Association. The non-partisan steering committee developed an agenda to focus on emerging issues in ballast water management and recent studies completed or underway. Over 70 individuals interested in the issue attended the workshop, representing the full range of perspectives on the matter. The workshop reflected a spirit of cooperation among diverse perspectives and a universal acknowledgement of the vexing problem of exotic species introductions via ships. At the close of the workshop there was a widely held sense that interested parties need to continue to work together in similar forums to achieve the common goal of eliminating exotic species introductions via ships.

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EXISTING AND PROPOSED BALLAST WATER LAWS AND REGULATIONS

LINDA SHEEHAN, DIRECTOR, PACIFIC REGION OFFICES, CENTER FOR MARINE CONSERVATION

Agenda

- Scope of the Problem
- Legal Framework
    a. Federal
    b. State
    c. Local
- Summary: Moving Forward
- Invasive species threaten:
    a. Economy: utilities, fishing, agriculture
    b. Environment: out-compete and cross-breed with locals, bioaccumulate toxics
    c. Human health: bacteria, viruses
- Costs high and growing: billions annually
- Established invasives are "here to stay"
- Ballast water is a major source of aquatic invasives
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, 16 U.S.C. §§ 4701 et seq. (NANPCA)
    a. Mandatory requirements for Great Lakes
- National Invasive Species Act of 1996, 16 U.S.C. §§ 4701 et seq. (NISA)
    a. Voluntary ballast water exchange/treatment

    b. Mandatory reporting
    c. Limits to effectiveness in controlling invasives

• Federal Water Pollution Control Act, 33 U.S.C. §§ 1251 et seq. (Clean Water Act)

a. NPDES Permit Program: Section 402

i. Petition to EPA; status

ii. Ocean discharge criteria applicable: Section 403

b. "Total Maximum Daily Loads ": Section 303(d)

• Marine Protection, Research, and Sanctuaries Act, 33 U.S.C. §§ 1401 et seq. (Ocean Dumping Act)

• National Environmental Policy Act, 42 U.S.C. §§ 4321 et seq.

a. Requires analysis of impacts from federal projects

• Endangered Species Act, 16 U.S.C. §§ 1531 et seq.

a. Section 7:

i. "Requirement to consult " regarding impacts of federal projects on endangered and threatened species

ii. Agency must ensure that federal action is "not likely to jeopardize" endangered/threatened species

<u>State Legal Framework</u>

• State Environmental Protection Acts

a. CEQA: Public Resources Code §§ 21000 et seq.

b. Requirement to adopt "feasible mitigation measures " for project 's significant impacts

• State Water Quality Laws

a. CA Porter-Cologne Water Quality Control Act: Water Code §§ 13000 et seq.

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b. State has broad authority to regulate discharges into state waters

• State Fish and Wildlife Laws

• State Legislation

a. California: AB 703

i. Details program based on state water quality law

ii. Short-term: Mandatory ballast exchange or equivalent treatment

iii. Longer-term: Updated treatments phased in as they become economically and technologically achievable

b. Washington: SB 6293

c. Michigan: SB 955, H.R. 4191

Local Legal Framework

- Local application of federal and state laws

    a. Clean Water Act Section 303(d): Application to the San Francisco Bay Area

- Challenges to local projects

    a. San Francisco Bay, Columbia River

- Individual port regulations

    a. Port of Vancouver, Port of Oakland

Summary: Moving Forward

- Numerous federal, state and local regimes applicable to discharge of ballast water
- Size of problem prompting increasing use of legal tools
- Stakeholder coordination and input key to effective and workable programs

EXISTING AND POTENTIAL TECHNIQUES FOR VERIFYING OPEN OCEAN EXCHANGES

MAURYA FALKNER, CALIFORNIA STATE LANDS COMMISSION

Mid-Ocean Exchange:

• Objective is to replace coastal water ballasted in ports with open ocean water.

• Rationale: coastal organisms discharged mid-ocean unlikely to survive and open ocean organisms discharged in coastal environments also unlikely to survive.

• Currently the only readily available option for managing the spread of organisms.

Current Verification Techniques:

• Monitoring Ship Operations

• Taxonomy

• Salinity

Monitoring Ship Operations:

Newcastle Method - shipboard audit

• Check paperwork - confirm accreditation

• Gather exchange information (when, where, duration)

• Gather vessel specifics (tank capacity, # pumps, pumping rates, energy loading on pumps)

• Check engine logs (confirm energy use matches exchange)

Problems:

• Qualitative

• Not applicable for all vessels

• Based on energy use

• Requires meticulous log keeping

• Requires considerable training

• Potential language problems

• Mid-ocean exchange only interim solution

Black Box - actively monitors BW operations

• Directly determines BW exchange volumes

• Uses flow meters

• Telemetry (GPS)

• Linked to remote monitoring system

Problems:

• Would require International implementation

• Expensive - especially for older vessels

• High maintenance requirements

• Complete exchange does not equal no Exotic Species Introductions

• Mid-ocean exchange only interim solution

Tank Access for Sample Collection

• Deck Hatches

• Sounding Tubes

Taxonomy:

• Evaluate indicator species - Ocean and coastal taxa differ significantly and can be used to verify if full exchange was conducted

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Port of Vancouver

• measures salinity

• collect & filter >100 liters of BW

• Harpacticoid copepods = coastal

Problems:

• Determining appropriate indicator species

- Effectiveness of exchange - exchange of BW does not equal exchange of organisms
- Moderate to extensive training
- Subjective in untrained
- High error rates in untrained

Salinity:

- > 30 ppt “suggests ” open-ocean water
- Effective quick screening tool for high and low salinity concentrations
- Samples collected using baler & evaluated using hand-held refractometer.

USCG

- Salinity < 29 ppt suggests no exchange or incomplete exchange

Problems:

- Ambiguous results
- Stratification and incomplete mixing
- Limited applicability
- Weak for verifying exchange

California State Lands Commission

Sampling protocol for verification:

- verify accuracy of paperwork
- check for BW Management Plan & IMO
- collect information on vessel specifics
    a. (pumps, rates, etc.)
- multiple sampling regime (upper/mid/bottom)
    a. exchanged tanks intended for discharge
    b. unexchanged tanks not discharging
    c. ambient water
    d. measure salinity

Washington State BW Management Program

Proposed Verification Protocol:

- Salinity
- Copepod Evaluation
- Pathogen Evaluation

Unlikely Verification Techniques:

- Dye Tracers: questionable value in verification
- Dissolved Oxygen & Nitrogen concentrations:
    a. fluctuates within BW tanks, requires site specific data, highly variable
- PAH 's & Metals: sample contamination

Potential Future Techniques:

- Optical characteristics (fluorescence) of BW
    a. flourophores, phytoplankton, chlorophyll

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    b. distinct differences between coastal & mid-ocean

- Fingerprinting
    a. DNA/RNA, proteins, pathogens

SUMMARY

- BW Exchange is not the answer & should be viewed as short term solution
- However its currently the only game in town
- No single quick reliable verification technique
- Need more $$ dedicated to evaluating alternative treatment technologies
    a. ship-board
    b. shore-based

POTENTIAL STANDARDS FOR BALLAST WATER DISCHARGES

STEVE MOORE, CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD, SAN FRANCISCO BAY REGION

Overview

• Why Standards?

• Current Forums Discussing Standards

• What a Good Standard Should Be

• Types of Discharge Standards

a. Potential Approach for Ballast Water

• San Francisco On-Shore Treatment Feasibility Project

a. Technical Issues Associated with Setting the Standards

Why Discharge Standards?

• We need to "set the bar" for Alternatives to Open Ocean Exchange (i.e.,

Treatment)

• Great Lakes Experience: Mandatory Exchange is Not Preventing Exotic Species

Introductions

• Public Accountability

Consensus: "We need a ballast water treatment standard"

• Sept. 1999: Great Lakes "Exotics Policy" Conf.

• Feb. 2000: Aquatic Nuisance Species Conference

• Mar. 2000: Aquatic Nuisance Species Task Force

• Ballast Water Steering Committee, Ad-Hoc Standards Workgroup – Draft Standard by August 2000(?)

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• Mar. 2000: Washington State Law passed

• Sept. 2000: Great Lakes Process Initiates to Set Standards

A Good Standard Should Be:

• Based on Best Available Technology

• Achievable (including Affordable)

• Verifiable

• Internationally Uniform

• Constant (or Predictably Variable) Over Time

• Technology "forcing " or "encouraging "

• Different with New vs. Existing Ships

• Ultimately (if not immediately) Protective of Public Health and Preventive of Invasions

• Set Soon!

Types of Discharge Standards

• Treatment-Based Standards

• Technology-Based Standards

• Water Quality-Based (or Risk-Based) Standards

Treatment-Based Standards

• Drinking Water Treatment in U.S.

• Treatment Processes meet Standard without Compliance Monitoring

• Surface Water Treatment Rule: Must use Filtration, or alternatively meet 8 treatment, monitoring, and inspection requirements.

• Inspections for Proper O&M of Equipment

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PROS

• Simple Yes/No

• Compliance Determined without Water Quality Monitoring (Saves Time and Expense)

CONS

• Could Dictate Structural Elements on Ships – Legally Questionable

• Still need Monitoring Information to Justify Simple Treatment Standard Technology-Based Standards

• Conventional Pollutants in Sewage Treatment Plant and Industrial Discharges

• BOD, TSS, total coliform, pH, etc.

a. Percent Removal (e.g., 85%)

b. Effluent Limits (e.g., 30 mg/l)

• Effluent Guidelines for Specific Industries

a. Best Practicable Control Technology Currently Available (BPT)

b. Best Conventional Pollutant Control Technology (BCT)

c. Best Available Technology Economically Achievable (BAT)

• Direct (NPDES permits) and Indirect (to POTWs)

Technology-Based Standards PROS

• Use Simple, Cheap Indicators to Evaluate Discharge Quality

• More Public Accountability

• Focus Outside the Ship’s Hull

CONS

• More Time and Expense to Determine Compliance

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• Still Need to Decide Which Parameters to Measure

Water Quality-Based Standards

• Measurements of Discharge calculated to achieve Water Quality Objectives in receiving waters

• For Exotic Species, Two Daunting Issues:

a. Taxonomy (identify how many exotics there are)

b. Predict Which Will Be Invasive

Risk-Based Standards

• “Black List ” or Target Species Approach

• Australian Approach (Open Ocean Exchange only)

a. Characterize Port Berths for Exotics

b. Identify Source Regions of Known Invaders

c. Physiological Limits (salinity, temp., latitude, etc.)

d. Expensive and Assumes no Evolutionary Response

Potential Standards for Ballast Water Discharges

• Idea: Technology-Based Standards leading potentially to Treatment-Based Standards, with a Risk-Based Component.

• As Discharge Information is Collected and Analyzed, Justification for a Simpler Compliance Program can Emerge.

• Based on Removal of Organisms in Today ’s “BPT ” – Open Ocean Exchange

a. 90 or 95% now

b. 99% in *x* years

c. 99.9% in *y* years

90-95% of what?!

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• Measure Indicators of Viable Organisms and Pathogens

• Algal Cysts and Spores, Invertebrates, etc.

• Density of Organisms, compared to an Average Coastal Density Standard for a

Specific Source Region

• Common Bacterial and Viral Indicators

• Needs More Work

San Francisco Estuary Institute (SFEI) On-Shore Treatment Feasibility Project

• Summer 2000

• Partnership with UC Berkeley and SF Southeast Treatment Plant

• Systematic Approach to Problem:

a. Select Test Organisms, Protocols, Assays

b. Assess Array of Potential Treatments

SFEI et al. Project – Criteria for Selection of Organisms

• **Representative of Those Found in Ballast Water**

• **Easy to Obtain, Culture, and Assay**

• **Hard to Remove with Treatment Processes**

• Target Species of Concern to Policymakers

• Comparable to Those Used in Other B/W Tests

(bold text are the criteria actually used by the Project team, due to lack of other B/W tests and limited scope of the target species approach)

SFEI et al. Project – Example Organisms to Measure

• Copepods (mature invertebrates)

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• Larval Invertebrates (e.g., veligers of mussels)

• Diatoms and Diatom Spores

• Dinoflagellates and Dinoflagellate Cysts

Conclusion

• Standards are Demanded Now

• Effluent Guideline Process Can Apply

a. Establish Preliminary Standard, say 95% removal

b. Establish Deadline, say end of 2003

• Not Enough Research Commensurate with Risks

a. Annual Cost of Aquatic Nuisance Species: $5 Billion and Rising

b. We need a "Biological Effectiveness" Indicator ASAP

FEASIBILITY OF ON-SHORE TREATMENT OPTIONS FOR CALIFORNIA PORTS

IAN AUSTIN, PH.D. AND SUSAN ZIELINSKI, DAMES AND MOORE

OVERVIEW

• Objectives

• Background

• Approach

• System Components

• Findings

OBJECTIVES

• Investigate feasibility of Onshore Treatment at California Ports

• Evaluate technical, operational, and economic feasibility

• Evaluation Criteria

• Technical: Can it be done using existing technology irrespective of cost (worldwide application needed)?

• Operational: Is it operationally possible without causing significant delays?

• Economic: How much will it cost?

BACKGROUND

• CAPA Phase I “State-of-the-Issue ” Study

• Exchange Efficiencies

• Ship Board Systems

• Existing Ballast Water Treatment Systems

• Tanker Terminals

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• Dry Docks

APPROACH

• "Compare & Contrast " present BW discharge practice with that needed for Onshore Discharge and Treatment

• Develop Conceptual Onshore Treatment System

• Develop Ballast Water treatment requirement estimates for 11 California ports using available SERC data

• Size system to meet BW rates at 11 Ports

• Cost system components and Port systems

• Evaluate technical and operational issues

PRESENT BW DISCHARGE PRACTICE

• Discharge BW for hull-clearance while approaching port

• Discharge to empty cargo tanks while approaching port

• Discharge BW while at berth to control list and trim

VESSEL RETROFITS

• Vessels will pump ballast water via main deck manifolds, port and starboard connections

• All vessels will need to have standardized connections at mid-ships / bunkering stations

• Discharge rates approximate cargo-loading rates

• Pumps to overcome 30 m head at rates of 1,000 m3/hr

BERTH & WHARF RETROFITS

• Most berths will need onshore connections

• Piping will need to accommodate peak vessel discharge rates

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• Assume 24" pipe diameter for wharf reticulation

• Right-of-way and environmental permitting

ONSHORE TREATMENT FACILITY

• Designed for averaged flows, peaks held in storage tanks

• Uses filtration plus UV disinfection - standard technology

• Treatment standard similar to treating secondary wastewater

• Solids density similar to secondary treated water

• 5 sizes: 0.001, 0.01, 0.1, 0.2, 1.0 MGD

COMPONENT COSTS

• Vessel Retrofits: Approx. $400K for containerships & bulkers

• Berth & Wharf Retrofits: $200/ft = $1 million to $29 million

• Storage Tanks: $3 million to $20 million

• BW Treatment Facility: $1.6 million to $2.2 million

• Outfalls: $100K - Viable if seawater discharge can be permitted

PORT SPECIFIC FINDINGS

Capital Cost Cost per Metric Ton

Smaller California Ports $7.6 mil $8.30 to Larger California Ports $49.8 mil $1.40

CONCLUSIONS

• Need BW Treatment Standards to allow meaningful technical and economic comparisons

• Operationally, not possible to discharge all BW directly to onshore facilities. Safety an issue with at-sea transfers

• Onshore treatment will be expensive, c.f., exchange costs

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• Timing: Still early in process of development of suite of potential treatment options

• Treatment options which would require significant capital investment should consider operator response

ADVANCES IN SHIP-BOARD TREATMENT SYSTEMS

KENNY LEVIN, FORMER VICE PRESIDENT PACIFIC MERCHANT SHIPPING ASSOCIATION

(Notes by Steve Moore, Regional Water Quality Control Board, San Francisco Bay Region)

<u>Ship-Board Applications</u>

• High Volumes (typically over 20,000 tonnes)

• High Flow Rates (1,000 metric tons/hr.)

<u>Lessons Learned</u>

• Attack the Problem While You're taking it Aboard

  a. Right at the Sea Chest

• Attack it in Transit

• Attack it while Deballasting

  a. Maybe Too Late

  b. Disposal of Screenings

<u>Certain Applications that Probably should be Eliminated from Consideration</u>

• Ozone

  a. Stainless steel piping, O& M too expensive

• Radiation

• Deoxygenation

  a. Hydrogen sulfide corrosion and loss of life

• Heat

  a. Thermal stresses

• Electromagnetic

<u>Promising Technologies</u>

- Two-Step Treatment (physical removal followed by physical/chemical deactivation of organisms)
    - a. Filtration/UV
        - i. Moderate volumes of ballast water
        - ii. Cruise Lines
    - b. Hydrocyclone/UV
- Biocides that Decay

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ADVANCES IN SHIP DESIGN FOR BETTER BALLAST WATER MANAGEMENT

SPENCER SCHILLING, VICE PRESIDENT, NAVAL ARCHITECT HERBERT ENGINEERING CORP.

Outline

- Existing Ballast System Considerations
- Why ships need ballast
- Current ballast system components
- Existing ballast tank configurations
- New vessel design options

Why Ships Need Ballast

- Cargo quantities vary
- Fuel consumed
- Therefore, use ballast to:
- Insure Seaworthiness
- Adequate Drafts Forward and Aft
- Reasonable Trim and Visibility
- Proper Load Distribution for Hull Strength and Stability
- Maintain Safe In-Port Cargo Operations
- Trim and List OK for Cargo loading/discharge operations
- Maximum drafts meet pier side limits
- Sufficient Stability

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- Proper Load Distribution for Hull Strength

Current Ballast Water System Components

- Sea Chest
- Intake/Discharge Line
- Pump
- Main Distribution Line
- Fill/Suction Line
- Vent Line

Sample Ballast Configurations and Experience with Exchange

- Single Hull Tankers
- Double Hull Tankers
- Bulk Carriers
- Containerships

Single Hull Tankers

- Small number of large ballast tanks
- Sequential exchange is often difficult
    a. complex multi-day sequences
    b. light forward drafts (slamming)
    c. diagonal exchange required
    d. bending stresses high
    e. no stability problems
- Overflow often more suitable

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Double Hull Tankers

- Large number (12-15) of smaller tanks
- Typically well suited for exchange
- Somewhat sensitive to bending stress

Bulk Carriers

- Similar to single hull tankers
- Sequential Exchange is often difficult
  - a. complex sequences
  - b. light forward drafts
  - c. bending stresses high
- Ballasted cargo holds are problematic
  - a. sloshing loads
  - b. bending stresses
  - c. minimum drafts

<u>Containerships</u>

- Ballast / Cargo profile very different from tankers
- Large double bottoms can be difficult to exchange
- On-board heel and trim control very beneficial
- Ballast transfer can be minimized by cargo planning
- Some tanks can remain full for entire voyage cycle

<u>New Vessel Design Options</u>

- Require no ballast

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- Require no discharge in port (BW retention)
- Provide for safe, easy, and effective exchange
- Facilitate on board treatment
- Facilitate discharge to shore treatment facilities
- Reduce organisms taken on board

<u>Require No Ballast</u>

- Practically impossible for cargo ships
- Shipped designed for inherent stability and strength(very conservative)
- Examples: none, but Passenger vessels come close

Require No Discharge in Port (BW Retention)

• Possible if no large cargo or consumable weight change in port

• Internal ballast transfer system for heel/trim

a. ex: Large Post-Panamax containerships

Options When Ballast Discharge Required

• Provide for Safe, Easy and Effective Exchange

• Smaller tanks (helps with stability and strength)

• Larger ballast pumps and lines

• Piping for safer overflow

• Piping for Improved mixing for overflow

a. ex: empty/fill:containerships, dbl hull tankers

b. flow through: bulkers, single hull tankers

Provide for Safe, Easy and Effective Exchange

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• Piping for Safer Overflow

• Overflow standpipe

• Improved Mixing for Overflow

• Three Quays multiple filling points

• Top down fill - "Brazilian Method"

Facilitate Treatment On Board

• Intake/discharge through treatment equipment

• Larger Pumps to compensate for head losses

• Sufficient power and space in engine room

Facilitate discharge to shore treatment facilities

• Discharge piping arranged for shoreside connection

• Larger Pumps for greater head

Reduce organisms taken on board

- Sea chests at alternate locations to avoid sediment intake
- Take ballast from clean shoreside facility
- Allow easy cleaning/removal of mud on tank bottom

Summary of New Design Features

- Larger ballast pumps
- Smaller tanks
- Flexible intake/discharge arrangements
- Piping modifications for exchange
- Piping modifications for internal transfer

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- Tank structure to ease cleaning of sediment
- Additional engine room space and power